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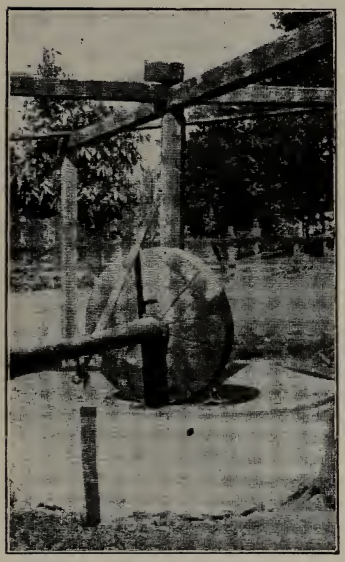

Olive-crusher at Camulos; first built in the State, aside from the one at San Diego Mission.

CALIFORNIA OLIVE OIL;

ITS MANUFACTURE.

By G. W. SHAW.

BULLETIN No. 158.

(Berkeley, Cal., June, 1904.)

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CALIFORNIA OLIVE OIL.

Although this Station has issued several publications* from time to time, both in the form of bulletins and of special articles in the Annual Reports, treating of various phases of the olive industry, yet the increasing number of inquiries as to the making of oil upon a commercial scale makes it evident that the brief discussion given in the bulletins issued, and the scattered condition of the other literature dealing with the subject (some of it having been destroyed by fire), render a more detailed discussion of the matter desirable at this time. This is the more necessary since the changed commercial conditions have made it almost imperative that, with few exceptions, the manufacture of olive oil, as with dairy products, be conducted by central plants on a considerable scale, rather than by numerous small outfits connected with the orchards themselves. This mill may be either coöperative, as with many successful creameries, or under private ownership, but, above all, the conditions surrounding its location and operation must be of the best, and the equipment of the mill must be of the highest efficiency. As the making of butter on the farm has rapidly given way to creamery methods, so the making of olive oil in a small way must surely give way to larger, centralized mills.

By thus centralizing the manufacture the operations of making and marketing the product can be better systematized, more skilled labor generally employed in the mill, and the large number of very indifferent brands, which in many cases are even inferior to its neutral oil competitors, cottonseed and peanut, can be materially lessened. As a result, especially if the industry be coupled with that of pickling, its natural complement, the manufacturer, on account of the larger output and the possibility of handling at a greater profit his highest grade of olives in the form of pickles, can afford to pay the grower a price for olives which will return a fair profit—a condition which can not be

*Notes on California Olives. Bulletin 92. By E. W. Hilgard.
Investigations of California Olives and Olive Oils. Bulletin 104. By E. W. Hilgard.
Olives: Pickling Processes; Notes on Varieties, Oil Machinery, etc. Report of Experiment Station, 1894–95. By A. P. Hayne.
Olives and Olive Oil. Report of Experiment Station, 1895–97. By A. P. Hayne.
Analyses of California Olives. Report of Experiment Station, 1895–97, page 193. By G. E. Colby.
Olives. Bulletin 123. By F. T. Bioletti and G. E. Colby.
Report on the Condition of Olive Culture. Bulletin 129. By A. P. Hayne.
Pickling Ripe and Green Olives. Bulletin 137. By F. T. Bioletti.

said to obtain generally where either of these industries is conducted on a very small scale on the orchard itself.

The improvement in the conditions surrounding the dairy industry since the establishment of central creameries in place of the individual churn on the farm is a standing example of the advantages to be gained by central plants both from the standpoint of the producer of the raw material and the manufactured product. The growing of the olive is a branch as distinct from the making of oil as the production of milk from the making of butter.

Under the present condition there is a wide range in the class of equipments used in the making of olive oil, ranging all the way from the most crude machines operated entirely by hand in a very haphazard manner, to the modern mill operated by power and equipped with the latest mechanical appliances for handling both the raw material and the finished product.

After a very careful study of the conditions which obtain in the manufacture of olive oil today, the writer can not recommend in any way the attempt to handle olives for oil on a small scale in connection with the orchard, where the idea is to make oil in a commercial way. In a small way, of course, for home use, hand work with a small plant can be utilized, but if it is hoped to manufacture oil at a profit commensurate with the care and labor expended, automatic machinery to reduce the cost and facilitate the handling of the goods so far as possible, and the most economical arrangement of the machinery in the building, to prevent so far as possible all doubling back on the work, should be employed.

It is true that certain makers, operating on a small scale and with hand apparatus, have made a success by establishing a limited clientage for their particular brand of oil, made of the highest quality; but the record of successes in this way is very small, and it must be said that those who entered into the business in a small way have become discouraged for one reason or another, and in some cases have entirely abandoned the making of oil.

In some cases this has been hastened from the fact that in the early stages of olive planting many varieties of olives were planted which were not well adapted to pickling on account of their inferior size and appearance, nor were they well adapted to oil-making on account of either the quality or the quantity of oil furnished. Another factor which has some bearing upon this condition has been the planting of fruit upon the poorest kind of soil, and the general lack of care given to the orchard after planting, under the mistaken idea that the olive tree would grow under the most unfavorable horticultural conditions. Indeed, this idea was fostered and encouraged by writers with facile pens in the earlier years of the industry. As a result of these teach-

ings large areas were planted under such unfavorable conditions that almost without exception they have given such poor returns as to discourage both the grower and his neighbors. The effect of errors of this kind is difficult to overcome. Such a condition, however, is not confined to this industry, but is to be seen in the early stages of all horticultural crops. As an offset, however, it should be distinctly understood that where the olive orchard has been planted upon soil well adapted in depth, quality, and physical condition, and the varieties planted have been those good for pickling and oil, and the orchard has been well cared for, favorable results have been secured, and are still being secured, and the orchard has returned a reasonable profit on the investment. It can not be insisted upon too strenuously that the olive, like other fruit-bearing trees, *appreciates a good soil and requires care, and under no other conditions can favorable returns be expected from it.*

It is not the object of this bulletin to discuss the horticultural features of the olive crop, further than to call attention to some of the causes which have tended to bring the olive crop into disrepute, and to call the attention of the readers of this bulletin to a discussion of the cultural conditions for the olive as set forth in Bulletin No. 129 of this Station.

Another serious obstacle to the success of the industry has been the indifferent quality of oil which has been made by so many operators. In the face of the competition of so cheap an oil as the cottonseed, the chief competitor of the olive as an edible oil producer, and the attendant high cost of producing strictly pure high-grade olive oil, unless the maker is prepared with the most efficient machines and so handles the olives as to turn out a strictly high-grade product, there is little inducement to enter upon the making of olive oil. That there should and would be a ready market in this country for all the olive oil which could be made in this State is evidenced by the importations of foreign oil as set forth below.

Imports of Olive Oil.

	1902.
Spain	$341,442 79
France	940,318 42
Italy	1,041,277 61
Greece and Turkey	10,974 90
Portugal	646 92
Austria	449 16
Total	$2,335,109 80
Total for nine months ending March 31, 1903	1,314,676 00
California production	150,000 00

To make this oil, however, at a cost which will compete with the foreign product, it is essential that only the most efficient machines be employed in the mills, and that these mills be of such capacity as to handle large quantities of olives in the most economical manner. This

can only be done by central mills located in regions best adapted in climate and soil to the growth of the olive. Under such conditions we may reasonably expect the oil industry, when coupled with pickling, to give reasonable returns upon the investment. As with the dairy industry it is only under such conditions that we can expect a uniform product to be made at the lowest possible cost, and that the highest price can be realized for the fruit.

There is a market demand for a high-grade, untainted oil, and it will not tolerate, at a price which will repay the cost of making, anything less than this. Its preference will rather be given to the lower-priced neutral edible oils appearing under the undistinctive name "Salad Oil." There are those who at first put up good products, and who know what a good product is when they taste such goods, but who have gone out of the oil business simply because, in spite of the finest kind of olive varieties, machinery and installation, they neglected the most elementary precautions and spoiled otherwise perfect raw material. At first they sold all the oil they could produce, but gradually drifted into careless methods, and in the same degree accustomed themselves to the foreign tastes in their oil that the market would not tolerate. The market is invariably blamed, but in this case it is not the guilty party; as in the case of wine, each producer is firmly convinced that what he produces is perfection itself, and if the market does not appreciate it, it is due to its depravity. Others there are, who failing to sell a spoiled article, blame the variety, soil, climate, and everything imaginable except their own carelessness.

Notwithstanding all that has been said there are many in the State who have made a success of the olive business, especially those who have limited themselves to the growing of olives and selling them to a mill prepared to handle the crop from a manufacturing standpoint, which under such conditions could afford to pay a fair price for the olives. The cost of oil machinery, the extreme care necessary to make a strictly high-grade product of either oil or pickles, and the necessity of creating a market, should deter *those with small capital* from going into the business with the idea of making oil alone for profit.

Location of the Mill.—It is presumed that parties contemplating the establishment of a mill will duly consider the suiting of capacity of mill to the supply of raw material that can be obtained at an equitable price and within easy distance. It must always be kept in mind that everything which can reduce the cost of handling and manufacture, so long as it does not reduce the quality of the product, counts for success, and a poor location of the mill either with respect to handling the crop or marketing the product may be the very thing which militates against success. The grower must realize a fair profit upon

his olives or the supply of raw material will gradually dwindle. It is probable that under ordinary conditions of crop the grower must realize not less than $20 per ton for the olives over and above the cost of picking, which may generally be considered as ranging from $8 to $10 per ton. At present the ruling price for olives is from $25 to $45 per ton, depending largely upon quality and variety. Strictly first-class pickling olives even bring as high as $65 per ton. Since the recovery in oil-making does not exceed about 50 per cent of the oil in the olives, under these prices the oil in the raw state will cost from $1 to $1.25 per gallon. It is to be understood that the higher price is that offered for pickling olives without grading, and that these are graded after purchase; thus the oil olives resulting from the grading of the pickling olives are purchased at a relatively high price, probably under these conditions sufficient to bring the price up to $40 per ton, where $30 is the ruling price for exclusively oil olives.

The location having been considered with reference to olive supply and transportation, attention should be directed to the water supply, especially if pickling is to be coupled with oil-making; and this must be recommended as the only feasible method in this industry. Only the purest water should be used in the preparation of olive products. The water should be free from excessive quantities of mineral salts and should especially be free from organic contamination and odors of all kinds. The supply should be bountiful and should be introduced into the building through large pipes tapped at several places convenient for work. The main pipe should be of sufficient size and the pressure adequate to permit the water to be drawn simultaneously at several different points without materially interfering with the flow at any one.

CONSTRUCTION AND EQUIPMENT.

The Building.—This need not be large, yet should be sufficiently roomy to allow ease and facility in work. Inasmuch as the presses and mill are of considerable weight the building should be solidly constructed where the weight of these machines is to be supported, and if the location is such that there can be a ground floor and basement the mill is best placed upon the ground floor, using the upper part of the building for the crusher, the ground floor for the grinding, and the basement for storage and bottling. The upper floor need extend over only a portion of the building, or be only a partial floor, upon which would stand the crusher only, where the operation is to be conducted upon a more limited scale. According to capacity of the mill and pickle works and its location, the building may be estimated to cost in the neighborhood of $1,000 to $3,000.

By centralizing the work more labor-saving machinery can be em-

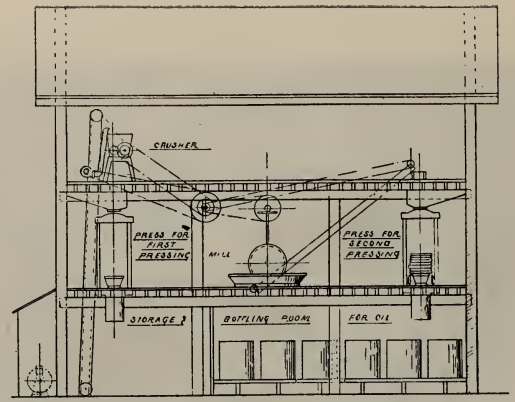
ployed, as has already been found quite feasible in some mills in the State, notwithstanding the somewhat widespread idea that the oil is seriously injured by such an innovation. The only thing needful under these conditions is to have the arrangements as simple and easy of cleaning as possible, and to exercise the same degree of cleanliness and care as is exercised in a modern creamery, for without such care and cleanliness it will be found impossible to make an olive oil which will stand the test of trade.

A general idea as to several arrangements which have proven and are likely to prove successful and convenient may be had from several of the illustrations which appear herein, especially that shown in Figs. 2 and 14. The subjoined line drawings, showing elevation and floor

FIG. 1. The largest olive-oil mill in California.

plans, are also commended as very convenient arrangements, where labor-saving devices are to be introduced.

Arrangement of Machinery.—The arrangement of the machinery in the factory is a matter of extreme importance in the way of economy of labor, and the larger the capacity of the mill the more important does this factor become. A certain prominent mill in this State employed during one season thirty-three men working twenty-four hours per day (two shifts) for the making of about five hundred gallons of oil. By the introduction of more modern machinery and adopting a more systematic arrangement, the management was able to reduce the number of men to eleven and the hours to twelve for the same amount of oil—a material saving which should go toward the profit in manufacture. Many mills are still so inconveniently arranged as to require a large amount of hand labor in shoveling and carrying the olives. By the



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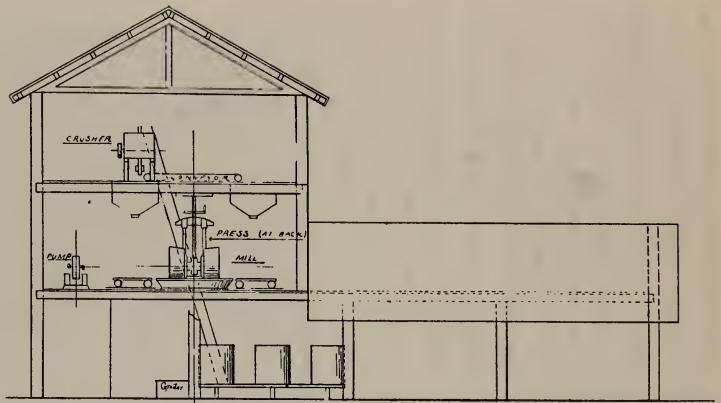

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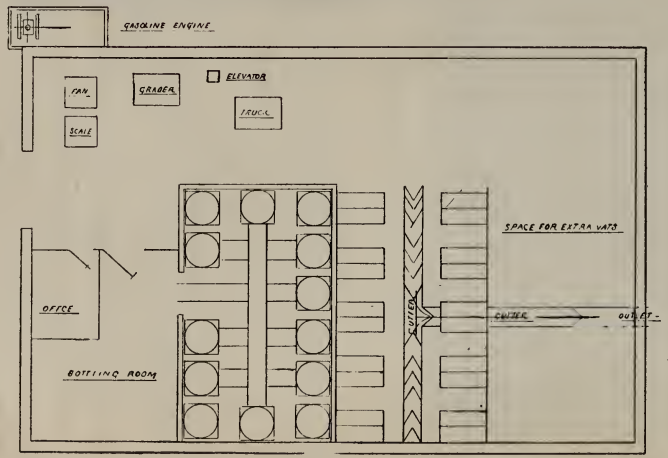

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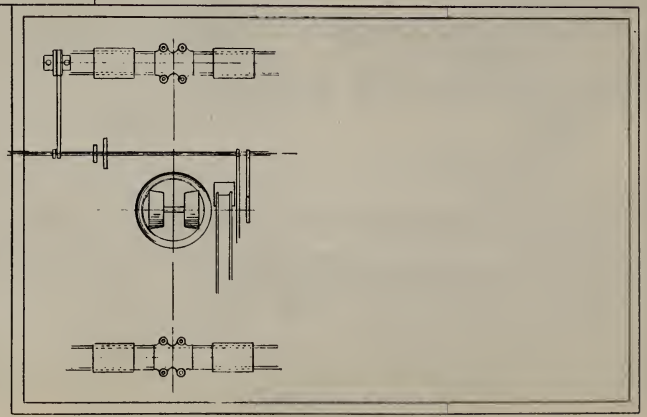


(D)

FIG. 2. DETAIL DRAWINGS OF A MODEL OIL MILL.

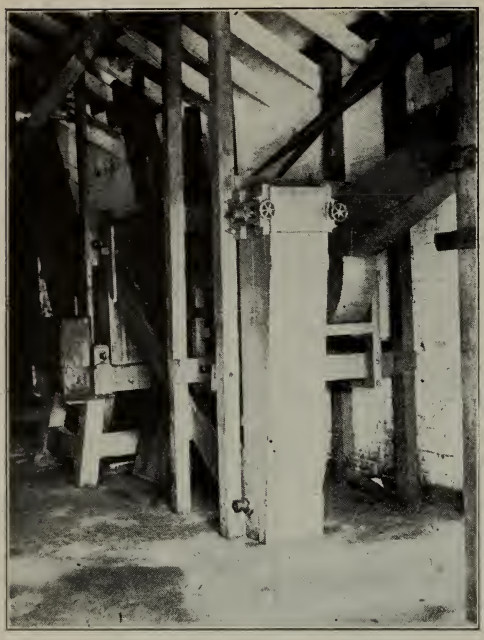


FIG. 3. Blowers, crushers, and elevators

introduction of link belt elevators and carriers, practically all of this hand work in transferring olives and pulp can be done away with, and by a proper arrangement of tanks and the introduction of pumps much of the hand labor in transferring the oil can also be saved.

A very practical and modern arrangement of trash-blower, elevator, crusher, and elevator leading to the first press is shown in the sub-joined illustration (Fig. 3).

PRELIMINARY OPERATIONS.

Picking the Fruit. — The making of olive oil really begins with the gathering of the fruit. Whether olives are to be used for pickling or for oil-making, it is very important that they should be picked carefully, at the right time. The largest quantity of oil possible from the olives is obtained from the ripe fruit, but the very highest grade is obtained from the fruit picked while it is still hard, but sufficiently ripe to allow the pit to be squeezed out without carrying away any of the flesh with it.

One can not be wholly governed by color to determine the proper time of picking, for in some cases the olives may become quite dark before the proper condition is reached, but again the fruit may still be quite green in color.

For whatever purpose the olives are to be used they must be gathered by hand. Raking or whipping the trees should never be allowed, not only for the sake of preserving the

FIG. 4. Olive pickers, with lined buckets.

fruit buds on the trees, but also on account of the bruising of the fruit and the consequent liability to fermentations being set up before the olives can be worked. The bruising of the fruit opens the way for the growth of fungi which ruin the good qualities of the oil, and every precaution must be taken to prevent such bruising. The olives must under no circumstances be poured from any distance onto a hard surface. One of the most convenient receptacles for the use of pickers is a padded bucket as shown in Fig. 4, the tops of trees being reached by means of the Titus ladder (Fig. 5).

Nothing is more conducive to systematic and economical handling of the fruit than a well-arranged place for receiving and weighing the fruit

FIG. 5. Gathering olives, showing the use of the "Titus" extension ladder on wheels.

as delivered. A well-devised systematic record of the fruit received is conducive to a perfect understanding between the grower and the packer or mill, as the case may be.

Grading.—The grading of the olives should be done as soon as possible after receiving them at the mill, the object being to separate those of the proper size and condition for pickling, provided that branch of the industry is followed. For this operation there are numerous machines in use, but there are few really satisfactory ones. Most of the graders bruise the fruit to such an extent as to injure it for pickling. One of the most successful is the so-called "Garvin grader" (Fig. 6), the olives destined for pickling being allowed to fall into

buckets partly filled with water to break the fall as they come from the machine. The grader at the same time removes much trash from the olives, the removal of which may be finished by the use of a blower, as indicated later on. An ordinary fanning-mill, such as is used for cleaning grain, is also occasionally used for the removal of trash.

For the making of oil the olives should be washed before crushing, in order to remove adhering dust or dirt, lest this impart a disagreeable flavor or appearance to the resulting oil.

THE EXTRACTION AND CLARIFICATION OF THE OIL.

Drying.—There are some working difficulties in the extraction of oil from freshly-picked olives, and in order to facilitate the work it is

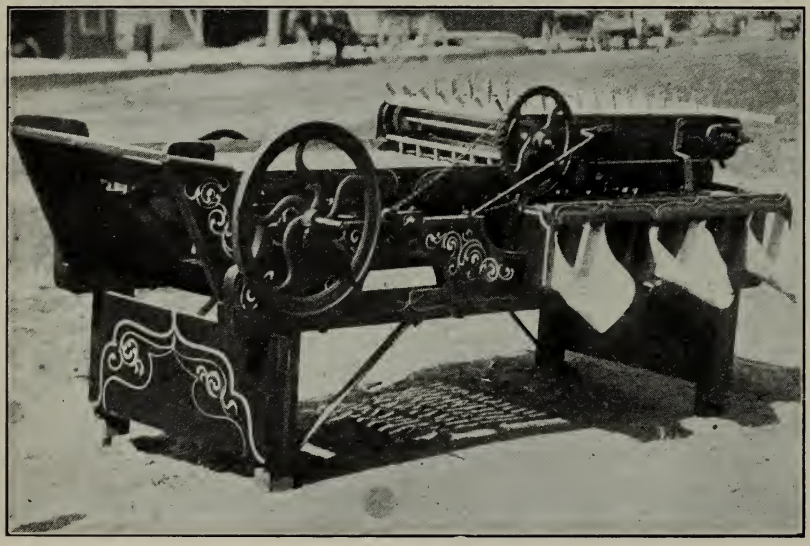


FIG. 6. The Garvin olive-grader.

best to remove a portion of their water, either by allowing them to remain on the trees for some time after becoming ripe in regions where there is no danger from frost, and thus shriveling them, or by partially drying them subsequent to picking. The former method has the advantage of requiring less labor, and at the same time there is an appreciable increase in the percentage of oil present in the olives so wrinkled—more than the increase arising from the loss of water—but it is very questionable whether the gain in the quantity of oil will compensate for the loss of time.

Drying subsequent to picking is done either by exposing the olives in shallow trays to the action of the sun and atmosphere, or by means of artificial heat in a drier especially constructed for the purpose. The

former method requires from fourteen to eighteen days, and much care has to be taken that the fruit does not become in the least moldy. In discussing the matter of drying by artificial heat, Mr. Ellwood Cooper, who has been one of the most successful of oil-makers, writes as follows: "This plan (sun-drying) can not be depended upon excepting in years when the fruit ripens early, and we have continuous sunlight with moderately warm weather. By artificial heat ranging from 110° to 130° F., the drying can be done in less than forty-eight hours. The crushing and pressing should follow without delay; that is, the fruit taken from the drier in the morning should be crushed and pressed the same day. Long intervals or delays in the process from picking the fruit to expressing the oil tend to rancidity. *To make perfect oil requires perfect system in the whole management.* All fruit picked during the day should be in at night, cleaned the following morning, and go into the drier immediately after the previous day's drying is out." Mr. Cooper's drier has a capacity of about one ton of olives per charge, or about 500 square feet of surface, which is equivalent to the work of about five pickers. With a larger press and mill there should be a corresponding increase in the drier capacity. The temperature in the drier should not exceed 130° F., and it is better to keep it somewhat below that point.

Where the drying is done without artificial heat great care has to be taken to prevent the olives from becoming in the least moldy, as the slightest indication of that condition will ruin the oil. Such drying is generally done by placing them in layers not more than three inches deep, on trays that are stacked in a dry, well-aired room, protected from the wind and the direct rays of the sun. The olives are turned over daily until they become well wrinkled. This requires about eight or ten days, according to the degree of temperature. If the partially dried fruit can not then be crushed immediately, it must be stored in a dark room where the temperature does not rise above 60° F. Here it may remain three or four weeks longer without any serious deterioration in the quality of the oil.

Crushing and First Pressing.—Considerable improvement in the methods of crushing, grinding, and pressing has been made during the last few years. The old-fashioned stone mills, with their slow, cumbersome, and irregular action and driven by horsepower, have been replaced by the more effective preliminary crushing by means of corrugated bronzed rollers for a preliminary treatment of the olives, which, after a first pressing to remove the larger part of the water, are then subjected to the more thorough grinding by means of massive double or single edge running wheels operated by power. The rollers used in the mill are shown in Fig. 7, and the entire arrangement of blower,

mill, and elevators in Fig. 3. These rollers are, of course, inclosed in a suitable feed and delivery box, as shown in the illustration of a smaller type of the same machine (Fig. 8). This crusher is so arranged that it can be adjusted at will to crush either the flesh alone, or both pits and flesh.

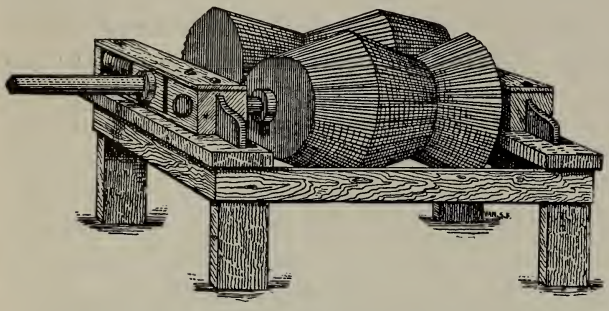


FIG. 7. Corrugated rollers used for crushing olives.

Another machine which meets with much favor is a so-called "barley crusher," shown in Fig. 9. This machine is very effective and is often the only crushing machine used, replacing entirely the edge-runner, but not to advantage.

The first pressing, which immediately follows this crushing, is only designed to remove the water of vegetation still remaining in the olives, and for this reason a press of only moderate power is required. In a well-appointed mill the crushed olives will fall into a chute immediately under the crusher, or upon an elevator delivering to the car of the first press. The first arrangement is shown in Fig. 2 (*a*) and the latter in Fig. 3. There are various types of presses used for this first pressing. One of the best which has come to the writer's attention is shown in Fig. 10. This type of press is sufficiently powerful and handles large quantities of material in a satisfactory manner for the first pressing, but is not powerful enough for the last pressing.

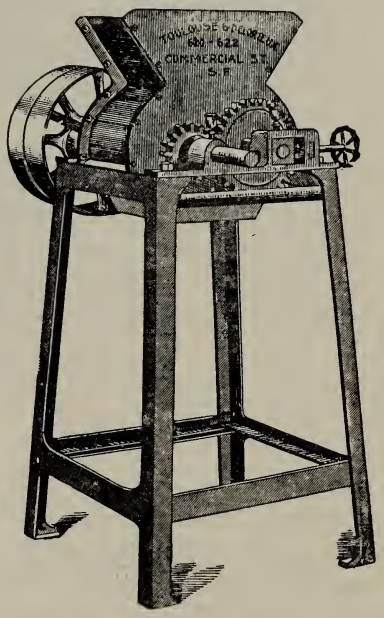


FIG. 8. Small olive-crusher.

As shown in the illustration, the mass of olive paste is placed in the press in such a manner that it will constitute a series of layers, each of which can drain off horizontally as the pressure is supplied. This is accomplished, among other ways, by means of wooden gratings and pieces of very strong cloth, or sacking, placed between the layers. The cloths used for this press do not have to be as strong as for the later pressing. A very serviceable cloth is that known as open-wove Texas

cotton, which costs about twenty cents per square yard. By this pressing the bulk of the mass is materially reduced and its handling in the powerful press much facilitated by the removal of the larger part of the water. *The pressure should be applied very gradually.* There is great temptation to hurry the pressing, but such forcing of the work only results in disappointment at the results obtained, since time is the element here for the effect to be realized upon the mass. From the liquid which runs out at this pressing is made the often talked of but seldom seen "virgin oil." In California practice it is rare indeed that this is made, this liquid being passed rapidly through the washer (see page 20), and the oil being collected and mixed with that from the next pressing. After the removal of the liquid by light pressure, the full power of the machine is *gradually* brought to bear upon the mass. A hand-screw press is sometimes used for this first pressing, but the greater economy of time and labor by the use of a power press probably warrants the extra small cost over a first-class hand press, if the work is to be undertaken in any except a small way. Under the latter condition the small grinder and press shown in Figs. 11 and 12 serve good purpose.

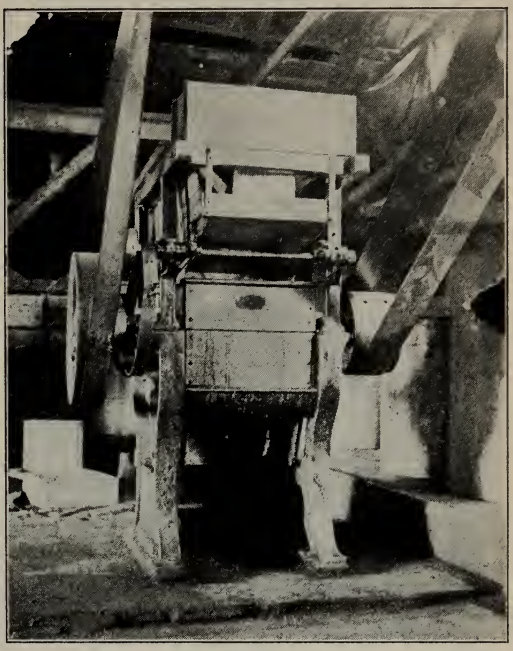


FIG. 9. Barley-crusher used for crushing olives.

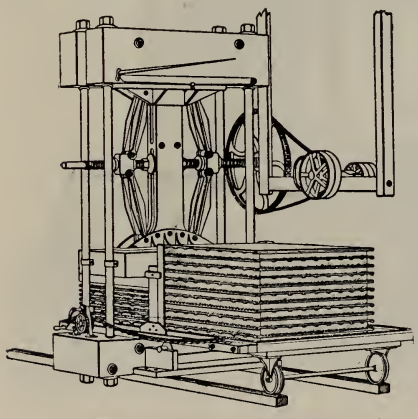


FIG. 10. Automatic press for first pressing.

The small mill consists of a round box mounted on a light frame and having a hopper in the center of its top through which the olives are fed. The crushing is done by a rotary plate, placed inside this box, which is corrugated or ribbed as shown and operates to grind the olives as they are caught between it and the under surface of the box cover,

which is also corrugated to match. This rotary plate is turned by a spindle passing through the bottom of the box, and is geared with a short shaft that is run by a flywheel and crank, as illustrated; or else by a belt-pulley when power is available. The spindle of the rotary plate is adjustable vertically, so that this grinding plate may be brought more or less close to the top of the box and made to perform the crushing to suit; the crushing being more or less fine according to its distance from the top of the box. The corrugations or ribs, it will be seen, are curved from center to rim, forming be-

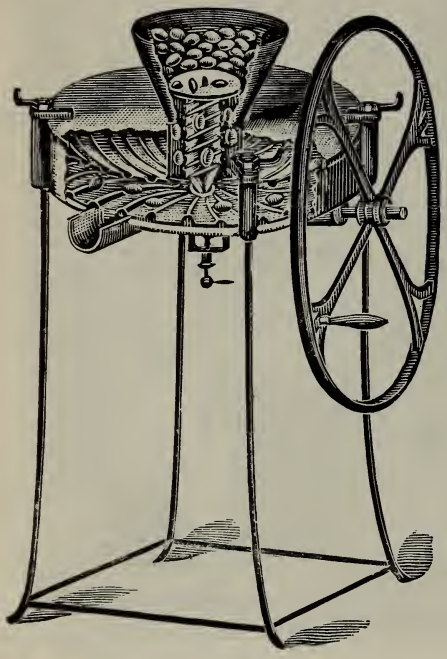


Fig. 11. Small olive-crusher.

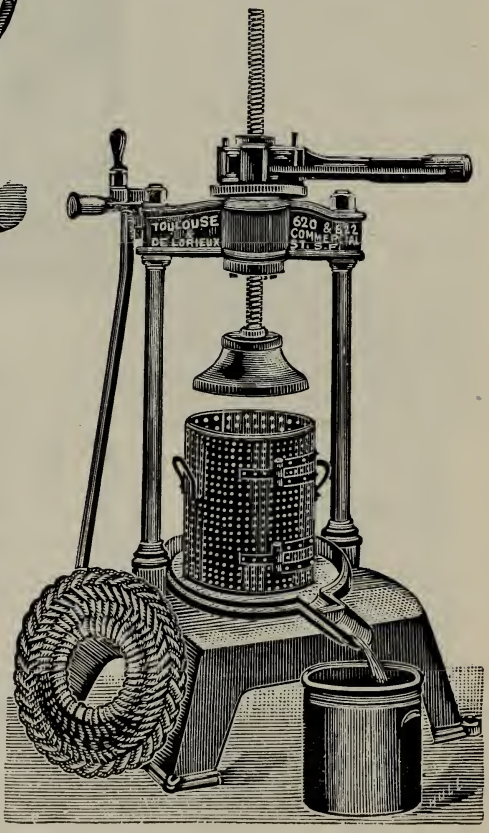


Fig. 12. Oil press.

tween them curved grooves in which the olives are lodged and their pits or stones stripped of flesh as the ribs of the plate and box pass or cross. The corrugations in the top of the box run in a direction opposite to that of the corrugations of the rotary plate. The adjustment of the rotary plate can be so nicely regulated that the pits contained in its grooves will not be crushed, thereby always insuring a sweet paste and consequently an oil of higher grade. In order to prevent clogging and to insure a constant discharge, a feed-screw is provided, located centrally inside the hopper and socketed in the rotary plate so as to be turned thereby. This screw drives down the olives as they are fed into the hopper and thus creates a forcing feed, the effect of which is to clear

the mill of the mashed olives and crowd out the latter, as fast as they are being crushed, toward the sides of the box; where they fall off the edge of the rotary plate and drop below it into the bottom of the box. Thence the crushed olives are taken up by scrapers secured to the under side of the rotary plate, and are carried round and pushed into the discharge opening and out of the spout into a bucket placed underneath to receive them. The little mill is made of iron, suitably tinned, and has a crushing capacity of one hundred pounds per hour.

The Grinding and Second Pressing.—The pulp on being removed from this press is thoroughly broken up in a limited quantity of water, and delivered to the edge-running grinder, which reduces it to a very fine condition. The finer the condition of this pulp the larger will be the quantity of oil recovered, other things being equal. However, some prefer not to crush the pits in either grinding, owing to the fact that it is supposed that they carry an inferior quality of oil, which tends to become rancid sooner than that in the flesh of the olive. There are few, however, *in actual practice* who do not crush the pits, and from a practical standpoint it is an open question whether the extremely small amount of oil carried by the pits impairs the oil sufficiently to have any material effect upon it in commerce if the other precautions of manufacture are carefully observed. Edge-runners can be so regulated as to do either the one or the other as may be desired. A modern edge-runner, together with a powerful hydraulic press, is shown in Fig. 13.

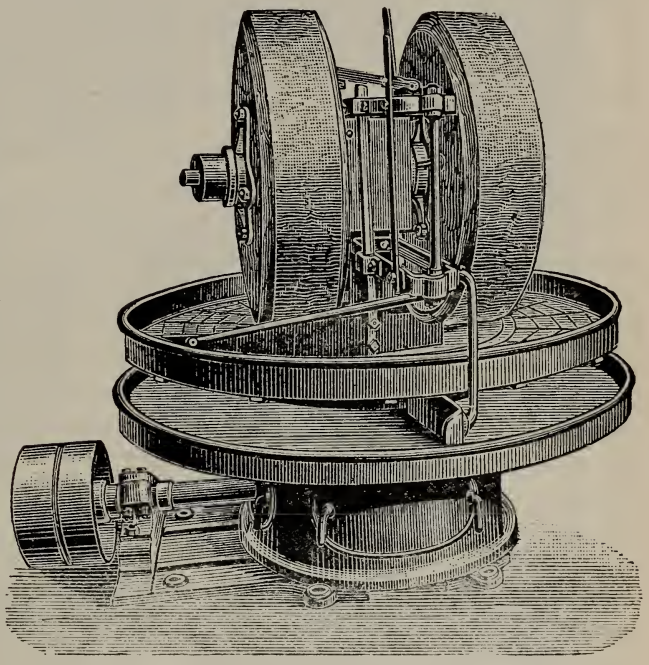


FIG. 13. Bottom-geared edge-runner.

Edge-runners may be had with the gearing either above or below. There is no difference in the effectiveness of the one over the other, and the type to be employed is largely determined by the available space. These edge-runners may be had with either double or single rollers,

which may in either case be readily adjusted to meet the needs of the various conditions and sizes of the olives being worked.

The mills may be had in four styles, similar in appearance but differing in the materials of which they are constructed. The most common is the cast-iron mill, but this is open to the serious objection of being very difficult to keep clean. Inasmuch as the use of metal is open to some objection, similar mills are made entirely of granite, but their cost is much higher. A very good substitute for the latter, and perhaps equally good for all practical purposes, is one with rollers and pan bottom made of granite, with sides of the pan of artificial stone bound with iron and firmly set to the granite bottom of the pan. It possesses the advantages of not bringing iron into contact with the mass, and at the same time of being much cheaper. The mills are furnished with mold boards, which follow the path of the olives and constantly turn them over and thereby secure an even grinding. The character of the grinding has much to do with the effectiveness of the pressing. The paste secured must be fine and of even consistency.

From the edge-runner the pulp is delivered to the second press by means of a link-belt elevator, as shown in Fig. 14, through a measuring chute as in the case of press No. 1. The press here used is best operated by hydraulic power, and may be had of various sizes and pressures. The pressures generally employed develop a total pressure of about 400 tons on an area of 36 inches by 60 inches, thus giving a pressure of about 370 pounds per square inch. The quantity of water required for the press is very small. It will be seen that there are two cars with this press as with the other, so arranged that while one is being pressed, the other is being emptied and refilled from the chute leading from the edge-runner, so the press can be kept constantly in operation. The edge-runner, elevator, and press in operation may be seen in the illustration of the mill of the Los Angeles Olive-Growers' Association. (Fig. 14.)

The cloth used upon this press requires to be much stronger than in the first case. Russian "Red Raven" linen press cloth has given excellent satisfaction, the cost of which is about $2.25 per square yard.

The oil removed by this second pressing, after clarification, constitutes essentially the "California Olive Oil" of commerce, as few operators go so far as to give a third pressing.

Under the ordinary practice in this State, investigation shows that only from one third to one half of the oil contained in the olive is removed by pressings, thus showing the heavy loss of material which the industry must sustain. There is little, if any, attempt made to remove the residual oil for any purpose at present. From reports received from the most extensive olive-oil makers in the State, the figures being based upon the season's work, *i. e.*, the total quantity of olives worked for oil and the total weight of the product, it appears that the

recovery ranges from 25 to 40 gallons of oil per ton of olives. One of the most experienced makers puts it this way: "My average is 56 pounds of olives to the gallon of oil."

The pulp remaining from this pressing makes a most excellent hog

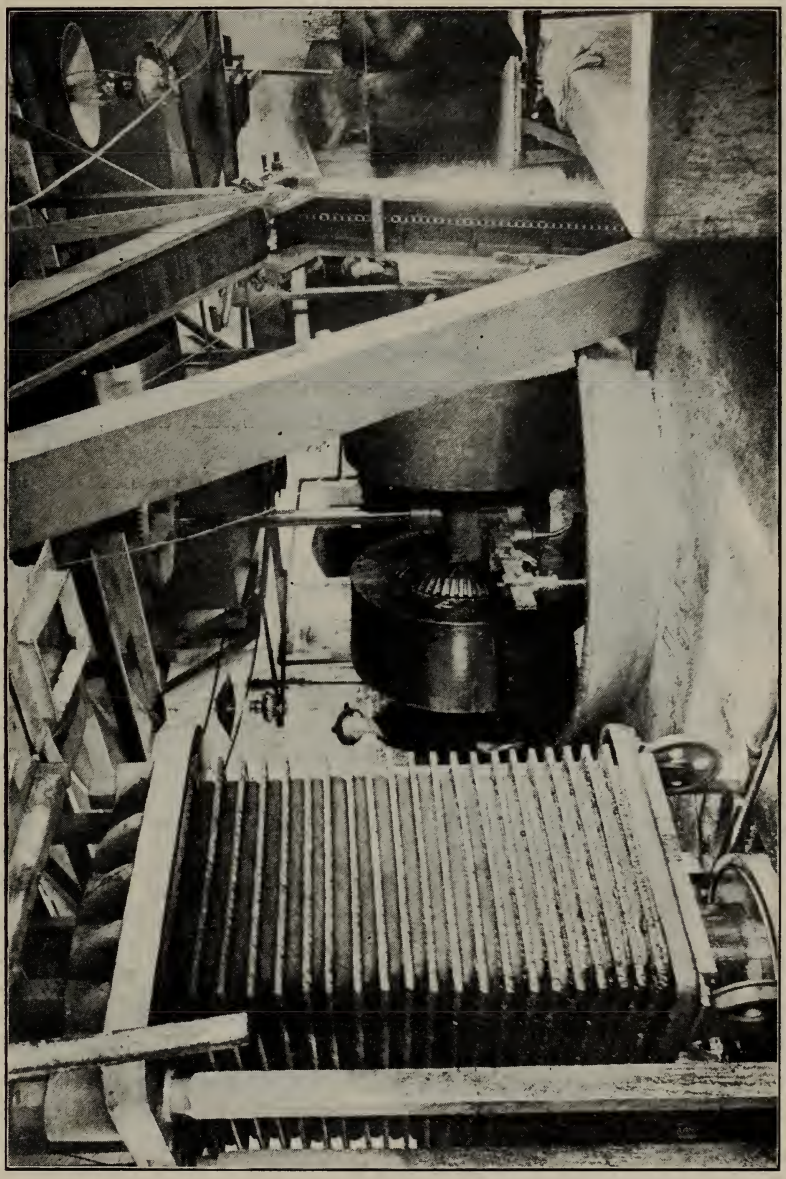


FIG. 14. Press-room of the Los Angeles Olive-Growers' Association.

or chicken food, and also a most excellent fuel. In those localities where fuel is scarce and high it may well be used for this purpose for operating the mill, furnishing nearly if not quite enough fuel for the entire operation.

The oil from this pressing, as well as that from the first, is separated as rapidly as possible from the black water which accompanies it. This is most effectively done by means of the oil washer (Fig. 15). The employment of this apparatus is a great improvement over allowing the press-liquid to settle in tinned vessels alone and removing the oil by skimming. It makes the separation of the oil almost instantaneous, and improves the quality by doing away with the prolonged contact of the oil with the air and the impurities of the liquid. The juices from the press flow into a tube, which opens into a small "drum" near the bottom of the tank, which is kept constantly full of water. This drum is perforated at the sides in order to allow the press-liquid to escape horizontally. Immediately above this drum is another larger one, perforated on the bottom, through which water is forced in jets. The water and press-liquid are thus thoroughly mixed in constant agitation. This results in the rapid deposition of the heavy impurities, and the equally rapid rise of the small, light oil-drops. The oil very quickly forms a layer on top and can be drawn off by means of a faucet appropriately placed. The apparatus is continuous in its operation, and the oil is obtained free from all the grosser impurities. It is still, however, very cloudy, owing to the presence of small, light particles of vegetable matter.

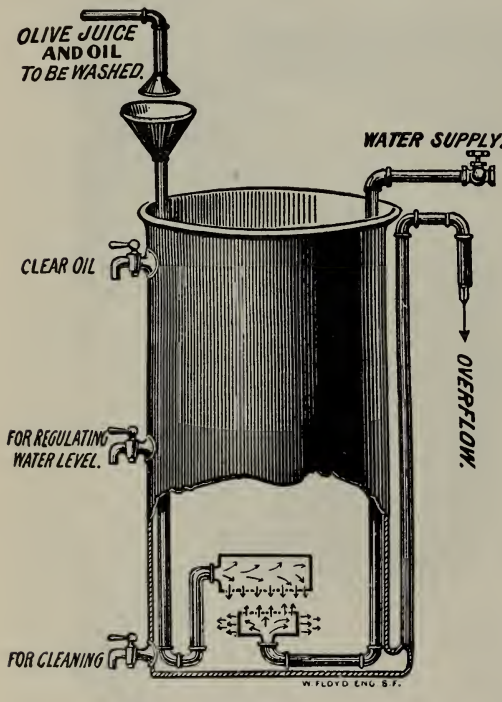


Fig. 15. Olive-oil washer.

"*Clarification.*—The oil must be made as bright as possible before being put upon the market. This can be done by various methods of filtration. Filtration, however, diminishes the freshness and aroma of the oil and injures the qualities that distinguish a fine olive oil from the clear, neutral oils extracted from cotton-seed. This is especially true of such filtering media as charcoal, which exert some absorbent influence upon the oil, diminishing its flavor. The best method of clearing, for oil as for wine, is by simple settling and decantation. For this purpose a series of settling tanks is made use of. These may be made of well-tinned metal, or of cement lined with glass

or other impervious substance. For small plants the first settling is conveniently made by means of a funnel-shaped apparatus such as that shown in Fig. 16. The steeply conical shape facilitates the rapid deposition of sediment. After standing for twenty-four hours in this apparatus the major part of the sediment is deposited and can be drawn off at the bottom. It is well, before running the oil into the settling tanks, to pass it through two or three inches of cotton wool. This is accomplished by means of a funnel with a perforated, horizontal cross-partition, upon which the cotton is placed. It takes, generally, about one month for the oil to settle sufficiently in the first tank, after which it should be drawn off carefully into the second, and so on until it is sufficiently bright. Three rackings are usually sufficient, and if all parts of the process have been well attended to, an oil is obtained almost as bright as can be produced by the most effective method of filtration, and having, besides, the agreeable and distinctive olive flavor and absence of greasiness which is lacking in all filtered oils." *

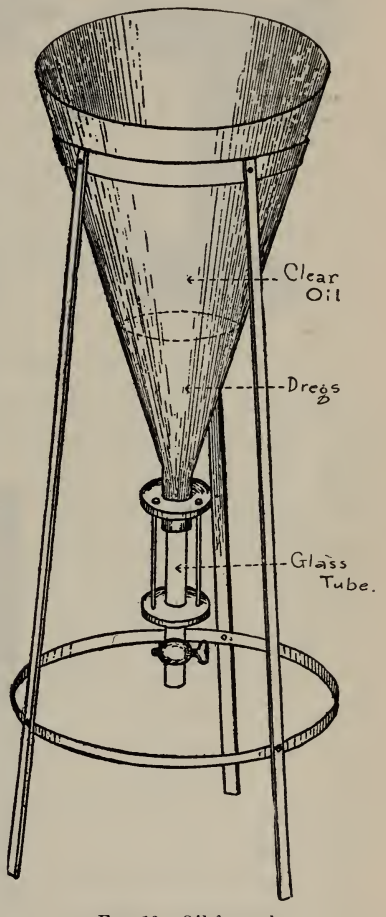
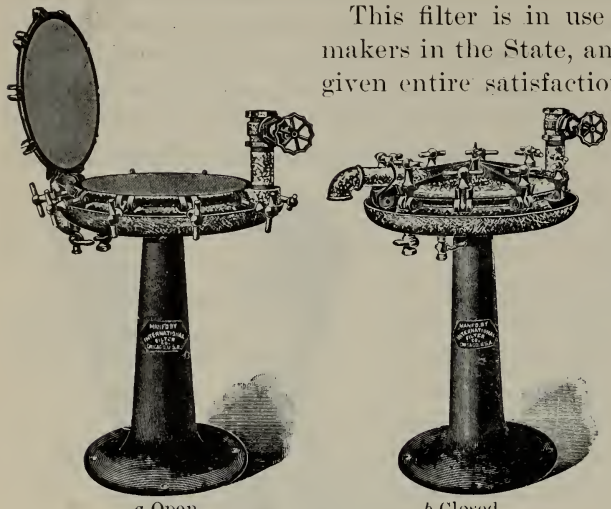


FIG. 16. Oil funnel.

Filtering.—It is not at all essential to filter oil in order to obtain a perfectly clear and bright product. The writer has seen unfiltered California olive oil which had been bottled ten years and was still as clear and bright as when first put up. The essential element in obtaining such oil is *time in which to obtain a perfect racking.* If sufficient time is not allowed a sediment will certainly settle in the bottles, which will as certainly spoil the market value of the oil. While the separation of this sediment, or the separation of the solid fats, is not a sign of an impure oil, but on the contrary is presumptive evidence of a pure oil, yet either is fatal to *the market* qualities of the oil. By the use of an effective method of filtration it is certainly possible to place the oil on the market sooner than without such filtration; yet unless this filtration be extremely good there may still be a gradual collection

* Bulletin No. 137, California Experiment Station.

of sediment. One of the most effective filters which the writer has found in use is known as the "International Filter" (Fig. 17).



a Open. *b* Closed.

FIG. 17. The International Filter.

This filter is in use by one of the best oil-makers in the State, and he states that it has given entire satisfaction. The filter consists of two shells, hinged together, and clamped around the edge by means of hand bolts. The inlet is in the lower shell, the outlet in the upper one, and the filtering is accomplished by means of filter discs locked securely around the edge between the two shells. The filtration is upward, which is particularly advantageous, as the heavier particles tend to settle away from the discs instead of clogging them. There are no corners or small passages, so that every portion of it may be reached for thoroughly cleansing, and there is a minimum of exposure to air. It occupies little space and can be operated either by pump, or in the case of olive oil preferably by gravity. The filter can be had in brass, block-tinned throughout.

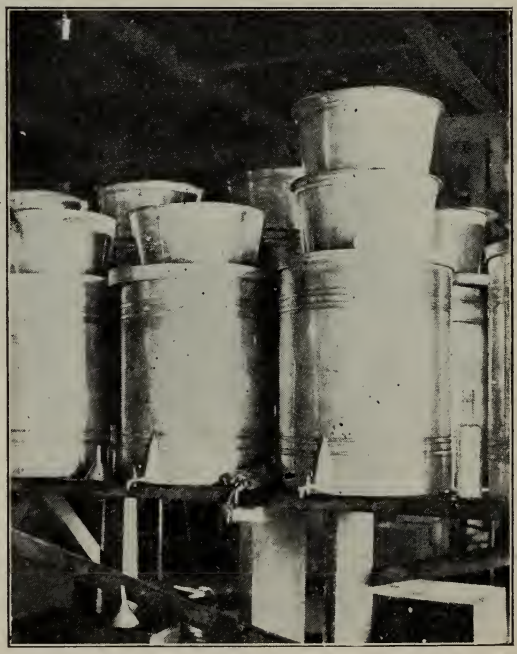


FIG. 18. Settling tanks surmounted with filters.

The more common form of filtration is by means of tin or glass funnels fitted with filter paper. The most efficient paper will be found to be No. 595, S. & SC., which may be had either in sheets or cut round in the desired size.

Mr. Ellwood Cooper writes: "The most common method is to have a series of five or six boxes, one above the other, each with cotton batting

in the bottom. The oil passing the sixth will be beautifully clear and ready for market. I use cylindrical vessels holding about three gallons each, one fitting in the other, in tiers of three, with fine wire sieves in the bottom of each. On these sieves I place two or three layers of cotton batting. The oil is passed from one tier to the other until clear." (Fig. 18.)

A very effective system of final filtration in use by one of the larger mills is shown in the accompanying illustration (Fig. 19). The oil after having passed through a preliminary filtration is racked off several times and finally passed through the filter shown. These filters

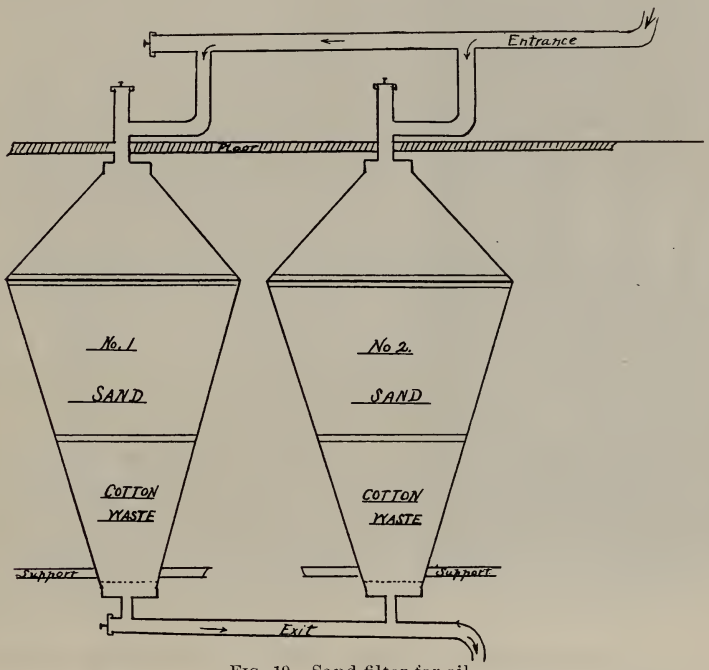


FIG. 19. Sand filter for oil.

are arranged in triplicate in the mill in question. In this mill the oil is drawn off from the final racking tanks, which hold about five hundred gallons each, arranged on a platform of sufficient height to allow another tank, rectangular, resting upon trucks which also bear a small "Challenge" pump, to be placed beneath so as to receive the oil as it is drawn off. (The racking tank, as well as the transfer truck and tank, together with pump, are shown in Fig. 20.) From the transfer tank the oil is pumped to a common supply tank located on a floor above the filters. The delivery is by a common supply pipe delivering to the three filters separately, as shown in the drawing. The oil first passes through eight or ten inches of sand, and finally through several inches of the best grade of cotton waste. The filtration is rapid and the prod-

uct comes out in a fine, clear condition. The filters are about 4½ feet high and 2½ feet wide at the widest portion, and the three have a capacity of about three hundred gallons of oil in twenty-four hours.

The tendency among most makers of olive oil is to attempt to bottle the oil too soon. While the oil will usually appear perfectly clear after three rackings at intervals of a month each, yet when bottled under these conditions a fine sediment usually settles, which not only affects the market value of that particular brand, but also has an indirect influence on all California oils. Where racking alone is depended upon for clarification, oil should not be bottled in a shorter time than six months.

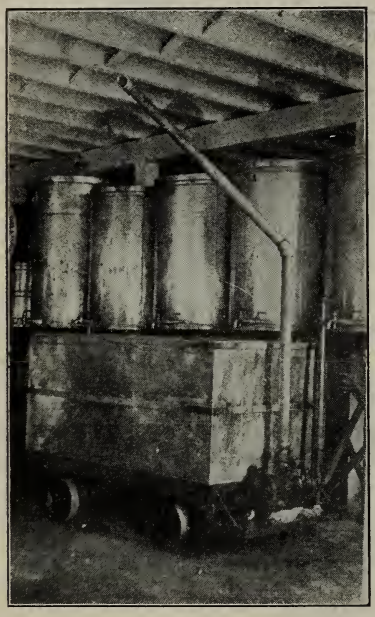


FIG. 20. Racking tanks and transfer car.

CENTRIFUGAL EXTRACTION OF OIL.

In the common method of extraction by pressure there are many difficulties which present themselves and tend to increase the cost of manufacture. Among these may be mentioned the duplication of presses, the time required, the low yield of oil, and the inconvenience of the cloths, or "scoutins," as the case may be, for holding the pulp.

As already pointed out, in order to secure a sufficient pressure, it is necessary either to operate two presses, one of medium and one of high power, or in lieu of this, to subject the mass to two pressings, at the expense of time. In the preliminary, or first, pressing no attempt is made to remove oil, but, as already pointed out, to remove a larger part of the free water, in order that the mass may stand up better in the press.

Under pressure the yield is far less than is desired. Considerable pains have been taken to ascertain as closely as possible what is the usual yield of oil in this State when the extraction is conducted under the usual conditions as represented both by the average practice and when the highest efficiency was employed. The results of this investigation show as follows:

Percentage of Oil in Pressed Pulp.	Per Cent.
Mill No. 1	13.5
Mill No. 2	10.7
Mill No. 3	11.8
Mill No. 4	17.0
Mill No. 5	16.0
Mill No. 6	14.0

In this connection we have no means of knowing accurately just what may have been the oil content of the original olives, but as a maximum it could not be assumed that they averaged more than 30 per cent oil, nor less than 20 per cent as a minimum.

Looking at the matter from the recoveries in oil reported, and using only those which are based upon the weight of the oil turned out during the season's run and the olives received and pressed, and taking the

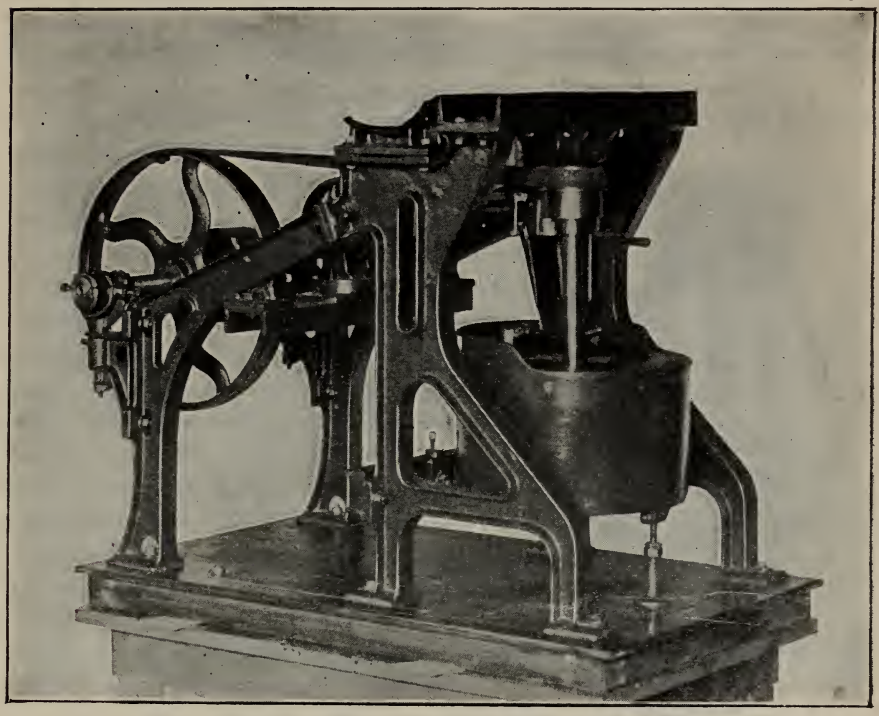


Fig. 21. A Weston Centrifugal Machine.

same range of oil content of the olives as above stated (20 to 30 per cent), we find as follows:

	Gals. Oil per Ton	Minimum Recovery.	Maximum Recovery.
Mill No. 1	30 to 40	48.5%	65.0%
Mill No. 2	30	32.5	48.5
Mill No. 3	30 to 40	48.5	65.0
Mill No. 4	40	45.0	65.0
Mill No. 5	32	34.6	52.0
Mill No. 6	40	45.0	65.0
Mill No. 7	36	39.0	58.5
Mill No. 8	32	34.6	52.0

Judging from the above we can fairly say that the range of recovery under the ordinary practice in the State is only about 35 to 65 per cent of the oil contained in the olive; or in other words, a loss exceeding one half of the oil contained in the olives.

Speaking along this line a foreign journal says: "The yield from pressure is low; the quantity of oil extracted by two pressings is, as a maximum, 20 per cent of the olive (ordinarily 15 to 18 per cent) when the fruit contains 30 per cent." Thus showing a loss of from 50 to 66 per cent of the oil present.

Further, the employment of bags or grass mats for holding the pulp is accompanied with several inconveniences, among which may be mentioned the imparting of a certain taste and color foreign to the oil itself. They absorb considerable oil during the course of the work, and unless extreme care be taken this becomes rancid and contaminates the oil. They wear out rapidly, and their replacement is expensive. The filling of them with the olive paste requires much care and labor. If too full, the oil remains in large quantity. If the distribution is irregular the pressure is unequal and it becomes difficult to hold the column upright in the press.

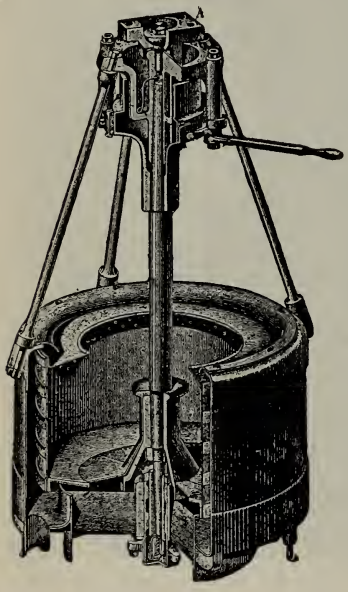


FIG. 22. Section of a Centrifugal, showing basket, curbing, and screens.

To overcome the difficulties mentioned above one of the most recent suggestions has been to employ in the place of presses centrifugals as in a sugar factory, where they are used to separate the molasses from the crystals. The method has met with some success in Algeria, and a number of mills in that country have introduced such machines. For other work in separation and drying these machines are used in many industries. The machine consists essentially of a perforated cylindrical metal basket turning in a casing which envelops it. The details of the arrangement, except the standards for supporting it, are shown in Fig. 22, and the machine actually used is shown in Fig. 21.

The machine used was made by the American Tool and Machine Company, Boston, and admirably served the purpose for the preliminary experiments, although in such a small machine the work would have been facilitated somewhat if the basket had been swung from the bottom rather than from the top, thus leaving the top open and free for work; which, however, is not a vital point in larger machines as used in the sugar house.

The basket of this machine was ten inches in diameter and six inches deep, the inside being lined in some cases with a single screen, at other times with two screens of different mesh, and at still other times there was added a cloth for the purpose of holding back more effectually the

fine pulp, and of giving a preliminary filtering at the same time that the oil was separated from the pulp. The machine was belted to a 1½-horsepower electric motor in such a manner that it was possible to run the basket at a speed of three thousand times per minute.

In the season of 1902 the experiments were begun so late that it was impossible to become sufficiently familiar with the machine and the methods of screening as to secure reliable results, and practically all the time was spent in preliminary work which had only an indirect bearing upon the question in hand. In 1903, however, definite work was outlined and carefully conducted, and the results are subjoined.

Work of Small Centrifugal.

Series.	Run.	Weight of Olives.	Weight of Pulp.	Oil in Pulp (or Olives).	Water in Pulp.	Solid Matter in Pulp (or Olives).	Weight of Oil in Pulp (or Oil).	Total Oil Lost in Pulp.	Total Oil Recovered.	Time.
		lbs.	*lbs.*	*Per cent.*	*Per cent.*	*Per cent.*	*lbs.*	*Per cent.*	*Per cent.*	*min.*
A	Olives	500		24.6	55.4	20.0	123.0			30
	1	500	280.8	13.6	36.4	50.0	38.1	31.9	68.1	30
	2	500	267.2	6.1	19.4	74.9	16.3	13.2	86.8	30
	3	500	258.8	14.9	41.3	43.8	41.3	34.6	66.4	30
	Average	500	268.9	11.5	32.7	55.8	32.3	26.2	73.8	
B	1	1000	555.2	14.1	40.1	45.8	78.3	31.4	68.6	
	2	1000	538.0	15.7	42.1	42.2	84.5	34.4	65.7	
	Average	1000	546.6	14.9	41.1	44.0	81.4	32.8	67.1	
C	1	1500	933.6	13.5	44.0	42.5	126.0	31.1	65.9	
	2	1500	854.1	15.9	40.6	43.7	135.8	36.8	63.2	
	3	1500	762.0	14.1	37.2	48.7	107.4	26.4	73.6	
	Average	1500	849.9	14.5	40.2	45.3	123.0	32.4	67.6	
D	1	2000	1042.4	15.1	44.2	40.7	157.4	31.9	68.1	
	2	2000	1029.3	14.8	46.2	39.0	152.3	30.9	69.1	
	3	2000	1060.1	11.9	40.7	47.4	126.1	25.8	74.2	
	Average	2000	1043.9	13.9	43.7	42.4	145.2	29.5	70.5	
E	1	2000	963.4	16.7	41.8	41.5	160.9	32.7	67.3	
G	1	1740	952.1	14.8	41.5	43.7	140.9	32.7	67.3	
	2	1740	885.3	15.9	35.2	48.9	140.7	32.7	67.3	
	3	1740	841.7	8.5	39.4	48.9	72.5	16.9	83.1	
	4	1740	975.5	14.4	38.4	52.8	140.5	32.6	67.4	
	5	2960	1574.0	13.2	40.8	54.0	207.7	27.1	72.9	
	Average	1984	1045.7	13.3	39.1	47.6	140.4	28.4	71.6	

The experiments were divided into several series, each of which was made up of several runs. In series A, B, C, D, Nevadillo olives from Dinuba were used. The olives were in good condition and were dried until they became moderately wrinkled in appearance before working, and at this time carried the amount of oil indicated in the first table.

Seventeen per cent of these olives consisted of pit at the time of the experiment. In this series the olives were first passed through a continuous-acting Enterprise fruit-crusher, the end cap of which was removed to allow the pits to escape.

This machine does not crush the pit, and for a very limited number of olives works quite satisfactorily where it is desired not to crush the pit, but for use in a centrifugal the flesh is not worked to a sufficiently fine condition by this grinder. The several series here presented were run with varying amounts of pulp to determine somewhat definitely the largest possible charge which could be worked to advantage in the small machine, and at the same time to ascertain the efficiency of the operation generally.

The greater part of the liquid (mixture of oil and water) is expelled during the first five minutes, or about one half of the total which can be obtained by this method. The operation is continued, however, and in from thirty minutes to forty-five minutes about 65 per cent of the total can be obtained, depending somewhat upon the condition of the olives and the thoroughness of the grinding.

At the outset of these experiments it was shown that the wire screen alone was entirely inadequate to hold back the pulp, and several trials were made with different kinds of cloth placed beneath the screen, between it and the outer basket, which finally resulted in the adoption of a light-weight flannel as giving the most efficient result. The contrast in the character of the centrifuged liquid with and without the cloth filter in the machine is shown by the following composite samples of "extract":

	Pulp in "Extract."
With single wire screen only	22.7 per cent.
With screen underlaid with flannel	5.6 per cent.

Inasmuch as this pulp gives much trouble in the clarification and its presence causes serious losses of oil, the importance of the above arrangement is manifest, and in all subsequent work the flannel was employed.

Contrasting the results from this machine with those indicated above from pressing, it is easily seen that the showing is quite favorable to the centrifugal method, yet is not as favorable as expected from the reports in the foreign publications mentioned above.

"There is obtained thus, in about ten minutes, a total yield of as " high as 90 per cent, depending upon the grinding of the olive."

"The ripe olives containing on an average 25 per cent of water of " vegetation and 30 per cent of oil, or a total of 55 per cent of liquid, " and the water of vegetation being expelled during the first few minutes, " the yield of 90 per cent indicated is proportioned as follows upon 100 " kilos of olives: 25 kilos of water of vegetation and 24 kilos of oil."

In these experiments there was experienced considerable difficulty from the packing of the pulp closely down upon the screen, thus interfering with the free flow of the oil and water, especially the former, and it was found that more efficient results could be obtained by loosening the pulp from the sides of the machine each fifteen minutes.

The action of the mass in the machine suggested the desirability of modifying the latter to some extent so as to allow a certain portion of the oil to escape from the central portion of the basket rather than to force it through the mass. This arises from the fact that at the outset, as the basket is set in motion, the water is of course thrown out, and on account of the difference in the specific gravity of the oil as compared with that of the pulp and the water its first tendency is to separate on the inside of the basket, and if after running the machine about fifteen minutes it be stopped a considerable quantity of pure and clear oil will be found to have separated itself, which could be drawn off, provided there was some satisfactory method of doing so. With these machines, as constructed, however, this can not be well done, and the oil which has once been separated in this way has to be driven through the mass now packed against the screen, thus requiring double work. It was not feasible at this time to so modify the machine as to allow this, and consequently the work was conducted by driving the oil through the mass by sheer centrifugal force, after the removal of the water.

With this idea of causing the oil to come to the interior more effectually and thus removing it from the center so far as possible, an attempt was made to introduce the mass into the machine, spin the material to the sides of the machine, and then introduce upon the interior surface of the mass a weighted screen which by centrifugal force would be pressed upon the mass. The weight of the screen used in this trial was 1225 grams. The results of the trial are set forth below:

	Weighted Screen.	No Screen.
Weight of olives	2000 grams.	2000 grams.
Percentage of oil in olives	22.0 per cent.	22.0 per cent.
Weight of oil in olives	440 grams.	440 grams.
Weight of pulp remaining	926 grams.	940 grams.
Percentage of oil in pulp	15.8 per cent.	16.0 per cent.
Weight of oil in pulp	146 grams.	150 grams.
Percentage of oil lost	33.1 per cent.	34.2 per cent.
Percentage of oil recovered	66.9 per cent.	65.8 per cent.

The results obtained from this trial were not considered promising enough to warrant further work in that direction.

Numerous trials were made with the small machine as to the effect of time upon the yield, but no effect was obtained commensurate with the loss of time by extending the time of spinning beyond thirty minutes, unless the mass was loosened from the screen and moistened

with water, which gave increasing results up to about one hour, which seemed to be the limiting time under the pressure that could be obtained with the small machine and the condition to which the pulp could be reduced.

The effect of loosening the mass and finally washing is well shown by the following data: The residual pulp from series A, B, C, and D was thoroughly mixed and reduced to such a consistency as would allow it to spread well in the machine, and placed a second time in the centrifuge, spun for thirty minutes, loosened from the screen, and mixed, and finally well washed with lukewarm water.

Weight of charge used	1500 grams.
Percentage of oil in charge	13.7 per cent.
Weight of oil in charge	205.5 grams.
Weight of final pulp	1217.0 grams.
Percentage of oil in final pulp	10.4 per cent.
Weight of oil in final pulp	126.5 grams.
Percentage of oil lost in final pulp	61.3 per cent.
Percentage of oil recovered in second run	38.7 per cent.

Thus from a pulp from which had been extracted 69.7 per cent of the oil in the original olives by the machine without loosening the mass from the screen, and which carried in the first pulp 13.7 per cent of oil, there was obtained in the manner indicated above 61.3 per cent of the oil still remaining, an increase well worth the trouble and time expended.

To be more certain of the results obtained with the small machine a larger lot of olives was secured and forwarded to Alvarado, where, through the courtesy of the Alameda Sugar Company, we were enabled to make a trial upon one of the forty-inch centrifugals employed in their sugar house. It is a machine of this size which would be employed in practice, and it was thought that the results obtained with this machine would more closely represent what might occur in acualt practice in working with this method.

The only olives which could be obtained were generally of poor quality as to condition, size, and oil content. They were far from such quality as would really indicate the effectiveness of the work under usual conditions.

In the first run at Alvarado 100 pounds of olives were used in the machine, but when spun upon the sides it was found that the weight could be somewhat increased. These olives showed on analysis as follows: Water, 36.9 per cent; oil, 15.0 per cent; total liquid, 51.9 per cent.

At the factory there was no convenient way in which the oil could be collected, and as the results could be as favorably judged from the condition and oil content of the pulp when the oil content of the original olives was known, no attempt was made to save the resulting extract.

The pulp was sampled each fifteen minutes during the run, and showed the following results for the several periods.

Time of Sampling.	Per Cent of Oil.	Per Cent of Water.
After 15 minutes	8.3	30.27
After 30 minutes	8.0	25.20
After 45 minutes	6.3	18.00
After 60 minutes	6.1	17.50

Or, figured back to the original oil in the olives, there was a recovery after the end of one hour of about 66 per cent of the oil in the olive, which does not differ much from the results in the case of the small machine.

The effectiveness of the work on this machine, while apparently the same as that with the smaller machine, must be looked upon as somewhat greater, inasmuch as the olives were in very poor condition for extracting the oil.

It should be stated here, however, that in the large machine there was experienced the same difficulty as with the smaller one, viz: the separation of the oil toward the interior of the basket at the outset, while the water was thrown off through the screen. While the oil was separated and did not show in the analysis of the pulp, yet the work could not be said to be entirely satisfactory from a working standpoint.

A second run was made, using the same olives, but washing thoroughly at intervals of fifteen minutes for a period of one hour. The results, however, did not vary essentially from those given above, as will be seen upon an examination of the figures set forth in the table.

The maximum quantity of olives which could be handled in a single machine of this size was found to be 150 pounds. Inasmuch as the large presses used in California olive mills on a commercial scale will work at one filling 3000 pounds of olives, it will be seen that the centrifugal must be twenty times as effective in time as the press, else there would be no gain by its use for this purpose. Under the conditions of this work, with the machine running at 1200 to 1500 revolutions per minute, it required at least one hour to remove the maximum quantity of oil from 150 pounds of olives; or, it would require two machines running for ten hours per day to do the work of a single press as used in California.

The results taken as a whole and compared with the most effective pressings, and allowance being made for the smaller charges that must be used in the case of the centrifugal as against the large press, can not be considered as offering much encouragement for manufacturers to adopt the former machine for final work, although it might be used for the preliminary treatment in the removal of water of vegetation and a small amount of oil.

The Use of the Centrifugal for Demargarizing Oil.—The most useful application of the centrifugal to the olive industry seems to be its employment as a demargarizing filter under controlled temperature conditions.

There are certain varieties of olives, notably the Redding Picholine, which unfortunately have been planted to a considerable extent in California, and which are so small as to rank among the oil class of olives. The oil from these olives, while present in the fruit in considerable quantities, carries a large proportion of fatty acids which separate out at a comparatively high temperature. While this is notably true of this variety (Picholine), it is more or less true of certain other varieties; and further, even in the same variety, there seems to be a difference in the relative tendency which these acids have to crystallize out, this possibly being somewhat dependent upon the state of development of the fruit and upon the soil producing it. Oil made from these olives, besides having a more greasy taste at all times, possesses a comparatively high point of turbidity and congelation, owing to which it must either be blended with oil from the better class of oil olives, as the Mission, thereby reducing the quality of the latter, or the separated fatty acids must be removed by filtration after cooling, else the oil on the shelves of the dealer assumes, in the winter months, a semi-solid, doughy appearance, spoiling entirely its commercial value while in that state.

With the Redding Picholine the point of turbidity seems to be 11° to 12° C., and crystallization begins about 8° to 9° C. As indicated in the earlier part of this paper, the crystallizing out of the margarin and possibly some other fatty acids does not indicate an impure oil, but rather the contrary, and that the oil-making quality of the olives is poor.

For oil from good oil olives the point of turbidity is 4° to 5° C., and the point of congelation 2° to 3° C.; but certain oils have the point of turbidity as low as 3° to 4° C., and a congealing point of 0° to 2° C., the latter being considered uncongealable in commerce.

Evidently the thing to be desired, then, in the case of those oils having the high point of turbidity and congelation, is to so reduce their content of fats of high turbidity and congelation point as to remove their tendency to show these characteristics to a marked extent as in the varieties named above. The attempt to use these oils in their original condition has forced many of them back on the maker, and has had its influence against California oils with some dealers.

To overcome this trouble an attempt was made to treat oils having this tendency in such a way as to bring them within the range of turbidity and congelation of the better class of oils. This is done to some extent even now in this State by cooling and filtration, which

evidently should be the basis of work in any scheme for this purpose, and in fact does form the basis of a system used in Marseilles for a so-called complete demargarizing of olive oil. It would seem to be undesirable, however, to completely remove the more solid fatty acids, as their presence to some extent is necessary to the keeping qualities of the oil, and if they be removed to the point indicated by the better class of oils then all is done which would appear to be essential.

To accomplish the desired result it is necessary to cause the more solid fats to form in comparatively large crystals by *slow* cooling of the oil to +6 or +7° C., and then to remove the more fluid oil by filtration. This latter work can be very quickly and easily done, and without apparent impairment of the oil, by the use of a small ten-inch centrifugal running at a speed of from 2500 to 3000 revolutions per minute. (Fig. 21.) *The most vital point in this work is slowness of crystallization*, thus securing a condition which works well in the centrifugal machine.

In the northern part of California, at least, there will be little difficulty of securing the correct conditions by exposing the oil to the atmospheric temperature at night, which, during the oil-making season, seldom fails to reach a sufficiently low point to bring about the separation of the solid fats in the oils from the varieties named. There is no reason why the desired condition can not be realized, however, from the reduction of the temperature by any other means, provided only that it be *gradually* done.

When in the proper condition the solids spread well on the screen and the work proceeds rapidly. The material left in the machine can be used for fancy-soap making, so that it is not an entire loss.

By this treatment it is possible to obtain from the class of oils under discussion an oil which will resist a temperature of +1° C. to +3° C., and will possess none of the greasy characteristics which were in the original oil. In the operation the oil will lose about 10 per cent of its weight when working under the conditions indicated, on account of the separated margarin, but the quality of the resulting oil will be appreciably higher and will bring a better price.

In this work, as with all in connection with the preparation of olive oil, *absolute cleanliness is the price of good oil.* It is also best that the portion of the apparatus which comes into contact with the oil should be tinned, so that it may not impart a foreign taste to the oil.

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